(12) EUROPEAN PATENT APPLICATION

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(54) Navigation system with capability of instructing running direction.

(57) A navigation system for displaying, on a display screen (100), road map information and running traces of a car superimposed thereon comprises a cathode ray tube (7) for displaying the road map information and information regarding the car running traces and the like, bearing sensors (2, 3) for detecting a running direction of the car, a detector (4) for detecting a running distance of the car by detecting a revolution of the car wheel, and a controller (1, 5, 6, 8, 9) receiving outputs from the bearing sensors and the running distance detector, for computing a current position of the car and selecting road map information corresponding to the current position for display thereof on the cathode ray tube. The controller sets specified circular areas (109 to 112) centered on respective crossings (105 to 108) on the road map information, detects arrival of the car at the entrance (122; 115) to a specified area (111; 109), determines an angular difference between an approaching running direction of the car and a destination bearing at the entrance, and gives, on the basis of the determined angular difference, a voice instruction for running of the car at the crossing to the driver.

FIG. I
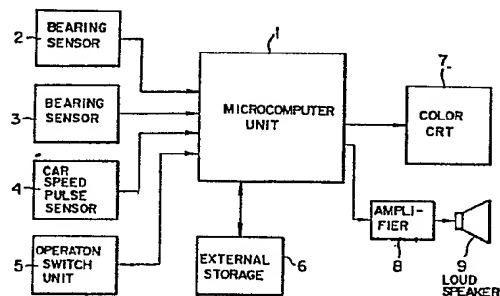
NAVIGATION SYSTEM WITH CAPABILITY

OF INSTRUCTING RUNNING DIRECTION

1   This invention relates to a navigator in which

road map information is displayed on a cathode ray tube

(hereinafter referred to as CRT) and running trace and

direction of an automobile are displayed by being

5 superimposed on the road map information.

Such a navigator is useful to practice an

easy running of an automobile toward a destination even

when the automobile runs in an area with which the driver

is unfamiliar.

10   In the past, a navigation system has been known

in which road map information is displayed on a CRT,

and as an automobile runs, a computation data, indicative

of a running trace of the automobile and computed by a

microcomputer on the basis of data from a bearing sensor

15 for inputting running bearings of the automobile to the

system and from a car speed pulse sensor, is displayed

by being superimposed on the road map information. This

navigation system can however display only results of

running when the automobile is practically driven. Accord-

20 ingly, in order to correctly reach a destination in an

area with which the driver is unfamiliar, the driver

must constantly be acquainted with the direction of the

destination and especially, a judgement as to whether   .

the automobile should run straight forwardly, turn to

25 the left or turn to the right at crossings is left up to

1 the driver. For these reasons, the navigation system is

less effective to serve as a navigator. Another

navigator intended to cope with these drawbacks has

been known as disclosed, for example, in Japanese Patent

5 Application Laid-open No. 26214/1983 entitled "Running

Information System". According to this latter navigator,

voice instructions are issued to indicate a straight-

forward, turn-to-the right or turn-to-the left running

at crossings, and the driver can advantageously be

10 instructed. To perfect the above operation, prior to

driving, the driver must key-in or input to the system

turn-to-the left, turn-to-the right and straightforward

running instructions in respect of all the crossings

on a road map by using a keyboard. This preparatory

15 operation, however, becomes extensive in proportion to

an increase in distance to a destination, and imposes

a great labor on the driver and hence is time consuming.

This invention therefore contemplates elimi-

nation of the above prior art drawbacks and has for its

20 object to provide a navigation system capable of

issuing voice instructions which apprize the driver of

car running directions at crossings through a preparatory

operation carried out within a reduced time.

According to this invention, the above object

25 can be accomplished by a navigation system wherein for

detection of crossings on a road map, a specified cir-

cular area centered on each of the crossings is set,

and when a car reaches a particular circular area

1 associated with a particular crossing, a running direction

at that crossing is automatically determined by computing

a destination bearing and a running direction of the car

when it approaches that area (hereinafter simply referred

5 to as approaching running direction), thereby simplifying

the key-in operation prior to driving. Thus, the inven-

tion is featured by means for setting specified circular

areas centered on respective crossings on road map

information and detecting a car which reaches a parti-

10 cular specified circular area, computing means for

computing an angular difference between an approaching

running direction and a destination bearing at an entrance

to the particular circular area, and running direction

instructing means responsive to computation results for

15 issuing voice instructions which apprize the driver of

a running direction of the car at a crossing associated

with the particular area.

The present invention will be apparent from

the following detailed description taken in conjunction

20 with the accompanying drawings, in which:

Fig. 1 is a block diagram schematically showing

the overall construction of a navigation system according

to an embodiment of the invention;

Fig. 2 shows a layout of individual switches

25 on an operation panel;

Fig. 3 is a block diagram showing details of a

microcomputer used in Fig. 1;

Fig. 4 shows an example of a display of road

1   map information which is useful for explaining the prin-

ciple of the invention;

        Fig. 5 shows running zones defined by referenc-

ing to a destination bearing; and

5   Fig. 6 is a diagram for explaining an example

of computation for the destination bearing and a running

bearing.

        Referring to Fig. 1 illustrating the overall

construction of a navigation system according to an

10   embodiment of the invention, there is seen a micro-

computer unit 1 which is the heart of the present navi-

gation system and which controls the operation of the

entire system. Details of the microcomputer unit 1

will be described later with reference to Fig. 3.

15   A bearing sensor 2 for detecting an absolute

bearing of a car running direction utilizes earth

magnetism and provides amplified analog quantities

representative of its X and Y components.

        Like the bearing sensor 2, a bearing sensor 3,

20   for example, in the form of an optical fiber sensor

detects a car running direction but provides an output

representative of a relative bearing.

        A car speed pulse sensor 4 generates an ON-OFF

pulse corresponding to a car speed which in turn is

25   inputted, as a signal representative of a running

distance of the car, to the microcomputer unit 1 of the

navigation system.

        An operation switch unit 5 is adapted for

1 inputting various running conditions of the car to the

microcomputer unit 1 and includes a plurality of switches

which are used for inputting to the various running

conditions as a digital signal.

5   An external storage 6 stores road map infor-

mation and various running conditions and takes the

form of, for example, a cassette tape controlled by the

microcomputer unit 1.

            A color CRT 7 serving as a means for displaying

10 the road map information and the like stored in the

external storage 6 is controlled by an output of a

color CRT control circuit included in the microomputer

unit 1.

            An amplifier 8 amplifies a voice signal and

15 cooperates with a loudspeaker 9 to provide voice instruc-

tions which apprize the driver of the running infor-

mation.

            The operation switch unit 5 shown in Fig. 1

includes a plurality of operation switches as shown in

20 Fig. 2. A setting switch 11 is adapted to set a running

start point and a running destination during initializa-

tion of the navigation system. A switch 12 cooperative

with the setting switch 11 is operated so as to set the

running destination of the car. A position switch 13

25 cooperative with a correction switch 19 is adapted to

correct a current position of the car. A bearing switch

14 also cooperative with the correction switch 19 is

adapted to correct the bearing sensors 2 and 3 adapted

1   to detect the running direction of the car. A group

of switches 15 to 18 are used to set and move cursors

which indicate a current position of the car displayed

on the color CRT 7. The cursors can be moved in any

5   directions labelled to the respective switches 15 to 18.

For example, when the switch 15 labelled with north is

pushed down, a first cursor (a cursor line extending

to an X-axis) is moved from the current position to the

north. With depression of the switches 16, 17 and 18,

10   a second cursor (a cursor line extending to a Y-axis)

is moved to the west, the first cursor to the south and

the second cursor to the east, respectively.

Details of the microcomputer unit 1 shown in

Fig. 1 are illustrated in Fig. 3. A microprocessor 31

15   is the heart of the microcomputer unit 1 and controls

the operation thereof. A RAM (volatile memory) 32 is

used for temporary storage of data in the course of the

computation and control operation by the microprocessor

1. A battery carried on the car and independent of a

20   system power supply feeds the RAM 32 and contents stored

therein are kept alive even when the system power is

turned off.

A ROM (non-volatile memory) 33 stores programs

necessary for various control operations and computation

25   operations by the microprocessor 1. An input/output

control LSI (large scale integrated circuit) 34 is

adapted to input various data from interfaces 36 to 39

to the microprocessor 1. The interfaces 36 to 39 are

1   for level conversion and waveform shaping of signals.

The bearing sensor 2 is connected to the interface 36,

the bearing sensor 3 to the interface 37, the car speed

pulse sensor 4 to the interface 38, and the operation

5   switch unit 5 to the interface 39. A control LSI for

small magnetic tape device (hereinafter referred to as

CMTC) 35 controls input/output of control signals and

data (such as road map information and various running

conditions) occurring between the external storage 6 in

10   the form of the small magnetic tape device and the micro-

processor 31. An interface 40 effects signal processing

necessary for steady transmission/reception of signals

between the CMTC 35 and the small magnetic tape device.

An LSI 41 which is the heart of a circuit for

15   transmission of various display data to the color CRT 7

controls all contents of the display data. The LSI 41

is simply referred to as CRTC 41.

A timing signal generator 42 generates a

reference clock signal to the CRTC 41, a clock signal

20   in the form of a serial signal to be transmitted to a

· video controller, and a timing signal which controls

gating (open or close) of a multiplexer 43.

The multiplexer 43 is responsive to the timing

signal of the timing signal generator 42 to switch a

25   address signal from the microprocessor 31 and an address

signal from the CRTC 41.

Graphic memories 44 to 46 for data of primary

colors, red, blue and green, to be displayed on the color

CRT 7 are accessible, through the multiplexer 43, to the microprocessor 31 and the CRTC 41 for reading and writing, thus combining the three primary colors to provide display of 8 kinds of graded color data.

A character memory 47 dedicated to storage of character information to be displayed on the color CRT 7 is also accessible, through the multiplexer 43, to the microprocessor 31 and CRTC 41 for reading and writing.

A character generator 48 stores patterned information of characters such as alphabetical letters, numerals, symbols or Katakana letters and responds to outputs of the CRTC 41 and character memory 47 to select and deliver one of various character patterns stored. Converters 49 to 52 operate in synchronism with the timing signal generated from the timing signal generator 42 to convert parallel data outputted from the graphic memories 44 to 46 and character generator 48 into serial data.

The video controller 53 effects level conversion and waveform shape processing of outputs from the parallel to serial data converters 49 to 52 so that these outputs meet a specification required for the color CRT 7. For data transmission, the video controller 53 is connected to the color CRT 7.

An interface 54 aids in the transmission of voice data to the loudspeaker 9 via the amplifier 8.

The operation of the navigation system having the construction described above will be described.

1   An example of road map information displayed on

a color CRT screen 100 as shown in Fig. 4 is useful to

explain the principle of the present invention. Also

shown in Fig. 5 are running zones about a crossing which

5   are selected in accordance with an angular difference

between an approaching running direction and a destina-

tion bearing of the car which is measured counterclockwise

with respect to 0° reference of the destination bearing.

In Fig. 4, displayed on the screen 100 of the

10   color CRT 7 are roads 101 to 104, crossings 105 to 108

of the roads on a road map, circular areas 109 to 112

centered on the crossings, intersections 113 to 128

on boundary of the respective circular areas 109 to 112

and the respective roads, a running start point 129,

15   and a destination 130. The destination 130 is outside

the color CRT screen 100, indicating that this destina-

tion is far away.

When an ignition switch is turned on, the Fig.

3 system inclusive of the microprocessor 31 is started

20   and initialized in accordance with an initializing program

stored in the ROM 33. As a result, the system is ready

for receiving commands issued by operating the switches

on the operation switch unit 5. Under this condition,

desired one or ones of the switches 15 to 18 are operated

25   to issue signals which, after subjected to the waveform

shaping by the interface 39, are fetched by the micro-

processor 31 via the input/output LSI 34. Pursuant to

block codes dividing the whole country of Japan, the

1   signals issued from the switches 15 to 18 after initi-

     lization are respectively used to increasè the column

     number, to decrease the row number, to decrease the

     column number, and to increase the row number. The

5   microprocessor 31 then sends to the CMTC 35 an instruc-

     tion for calling road map information selected by the

     setting of the switches 15 to 18, and this call instruc-

     tion is sent to the external storage 6 via the interface

     40. Based on this instruction, the road map information

10   is read from the external storage 6 and written into the

     graphic memories 44 to 46 via the interface 40 and CMTC

     35 under the control of the microprocessor 31. Data of

     the graphic memories 44 to 46 are sent to the data

     converter 49 to 51 under the control of the CRTC 41 and

15   subjected to parallel to series conversion at the timing

     of the timing signal generated from the timing signal

     generator 42. The thus obtained serial data is sent to

     the color CRT 7 via the video controller 53.

          The driver then operates the switches 15 to 18

20   to move the first and second cursors on the displayed

     road map information, thereby setting a running start

     position at an intersection on the cursors. Thereafter,

     with the setting switch 11 operated, the running start

     point 129 shown in Fig. 4 is written into a particular

25   address of the RAM 32 via the interface 39 and input/

     output LSI 34 under the control of the microprocessor

     31.

          Subsequently, road map information containing

1   the destination 130 shown in Fig. 4 is displayed on the

screen of the color CRT 7 in a similar manner that the

running start point is set and thereafter, the driver

operates the switches 15 to 18 to set the destination

5   130 at an intersection on the cursors. At this time,

the destination setting switch 12 is operated so that

data for the destination 130 is written into a particular

address of the RAM 32 under the control of the micro-

processor 31. After the running start point and desti-

10   nation have been fetched by the system, the microprocessor

31 computes distances in terms of X and Y coordinates

between the running start point 129 and the destination

130 as well as a bearing of a straight line connecting

from the running start point 129 to the destination 130.

15   Thereafter, the distances and the destination bearing

are stored into a particular address of the RAM 32.

     After completion of the above operations,

as the car starts to run, as shown in Fig. 4, from the

running start point 129 to the destination 130 along

20   the road 102, signals from the bearing sensors 2 and 3

undergo waveform shaping at the interfaces 36 and 37

in accordance with a period of a pulse from the car speed

pulse sensor 4 and are sent via the input/output LSI 34

to the microprocessor 31 where they are computed to

25   determine a bearing data which in turn is stored in a

particular address of the RAM 32. A running distance is

determined by counting and computing for a predetermined

time the number of transmissions of the signal from the

1   car speed pulse sensor 4 to the microprocessor 31 via

the interface 38 and input/output LSI 34. A result of

computation is stored in a particular address of the

RAM 32.

5   The microprocessor 31 computes a running trace

on the basis of the bearing data and running distance

data, and a computation result is written in the graphic

memories 44 to 46. Running trace data written in the

graphic memories is displayed on the color CRT 7 in

10 the same manner as the road map information. When

preparing the road map, the circular areas 109 to 112

shown in Fig. 4 are specifically set as white data, i.e.,

data being not displayed on the display screen to provide

an area of a radius of 50 m centered on each of the

15 crossings 105 to 108. When the car running from the

running start point 129 to the crossing 107 along the

road 102 reaches the intersection 122 on the boundary

of circular area 111 and the road 102, the microprocessor

31 computes an approaching running direction or bearing

20 of the car based on outputs of the bearing sensors 2 and

3, and a destination bearing of the destination 130 as

viewed from the intersection 122.

To explain results of the above computation,   .

the destination bearing is taken as a reference of 0°

25 as shown in Fig. 6. Since, in Fig. 6, the destination

bearing as viewed from the intersection 122 is denoted

by 131 and the approaching running direction of the

car at the intersection 122 is denoted by 122, the angular

1 difference between the destination bearing 131 and the

approaching running direction 132 is 90° in this example.

Three zones are principally defined with

respect to the destination bearing of 0° as shown in

5 Fig. 5. More specifically, a straightward running zone

is defined by the angular difference between the desti-

nation bearing 131 and approaching running direction

132 which is less than 30° and larger than 330°, a

turn-to-the right running zone is defined by the angular

10 difference which is larger than 31° and is not greater

than 180°, and a turn-to-the left running zone is defined

by the angular difference which is larger than 180° and

is not greater than 330°. Referring to Figs. 5 and 6,

since the angular difference between the destination

15 bearing 131 and approaching running direction 132 at

the intersection 122 is 90° in this example, this angular

difference is applied to the Fig. 5 zone classification

to determine the turn-to-the right running zone. When

the computation is effected to select one of the zones

20 shown in Fig. 5, the microprocessor 31 selects a code

representative of the determined zone from codes repre-

sentative of straightforward, turn-to-the right and

turn-to-the left runnings which are stored in the ROM 33,

and sends the selected code via the input/output LSI 34

25 and interface 54 to the amplifier 8, so that the loud-

speaker 9 apprizes the driver of a voice instruction

corresponding to the selected code. In this example,

the angular difference between the destination bearing

1   and approaching running direction falls within the turn-

     to-the right zone and hence the driver is apprized of

     a voice instruction "please turn to the right". Under

     this condition, the driver turns the car to the right

5   at the crossing 107 and causes the car to enter the

     road 101. Since in this embodiment the approaching

     running direction and destination bearing are systematical-

     ly computed when the car reaches the entrance to the

     circular area, no computation is effected at the inter-

10   section 121, i.e., exit from the circular area and the

     next computation and comparison will be effected in

     respect of a destination bearing and an approaching

     running direction at the intersection 115. At the

     intersection 115, the angular difference between the

15   approaching running direction and destination bearing

     approximates 0°, and the driver is apprized of a voice

     instruction "Please go stragithforwardly" from the loud-

     speaker 9.

          As described above, the navigation system

20   according to the present invention is advantageous in

     that since the guiding function gives a voice instruc-

     tion for running at a crossing to the driver 50 m before

     the crossing on the road map information, drive labor

     imposed on the driver can be reduced considerably, that

25   since the preparatory operation necessary for the above

     operation can be completed by setting only a destination

     without requiring sophisticated key switch operations,

     the driver can be freed from considerable labor and

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1 time for the preparatory operation, and that labor and

time required for the driver to operate key switches

can be fixed and minimized irrespective of the distance

to the destination.

1 CLAIMS:

' 1.   A navigation system for displaying, on a
display screen (100), road map information and running
traces of a car superimposed thereon comprising:

5   a cathode ray tube (7) used as a display means
for displaying the road map information and information
regarding the car running traces and the like;

at least one bearing sensor (2, 3) for detect-
ing a running direction of the car;

10   running distance detector means (4) for detecting
a running distance of the car; and

control means (1, 5, 6, 8, 9) receiving output
signals from said bearing sensor and running distance
detector means and computing a current position of the
15 car, for controlling car running information such as the
road map information, running trace and running bearing
corresponding to the current position of the car and
displaying the car running information on said cathode
ray tube,

20   said control means including:

external storage means (16) for storing the
road map information and the car running information;

a central control unit (1) for controlling said
external storage means, computation of the current
25 position of the car and display of the road map infor-
mation; and

means (8, 9) for instructing the driver in
running direction,

whereby specified circular areas (109 to 112)

centered on respective crossings (105 to 108) on said

road map information are set, arrival of the car at an

entrance (122; 115) to a specified area (111; 109) is

5 detected, an angular difference between an approaching

running direction of the car and a destination bearing

at the entrance is determined, and the determined angular

difference causes said running direction instructing

means to apprize the driver of a running direction at a

10 crossing (107; 105).

2. A navigation system according to Claim 1,

wherein said running direction instructing means gives

a voice instruction to the driver.

3. A navigation system according to Claim 2,

15 wherein said running direction instructing means comprises

a loudspeaker (9) for issuing the voice instruction.

4. A navigation system according to Claim 1,

wherein the angular difference between the approaching

running direction of the car and the destination bearing

20 is referenced to the destination, and a straightforward

running is decided when the angular difference falls

within ±30°.

5. A navigation system according to Claim 4,

wherein a turn-to-the left running is decided when the

25 angular difference falls within a range of from 30° to

180°, and a turn-to-the right running is decided when

the angular difference falls within a range of from

180° to 330°.

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6.   A navigation system according to Claim 1,
wherein said specified circular area centered on said
crossing has its boundary which is distant a predetermined
distance from said crossing.

7.   A navigation system according to Claim 6,
wherein the boundary of said specified circular area is
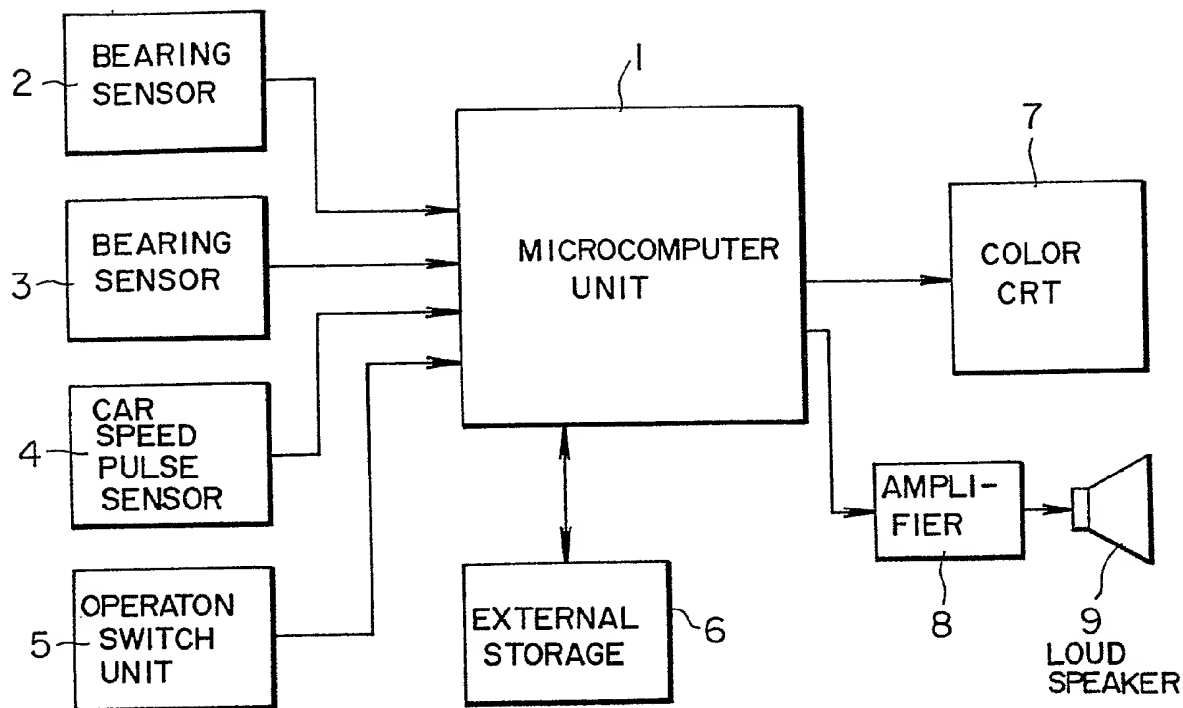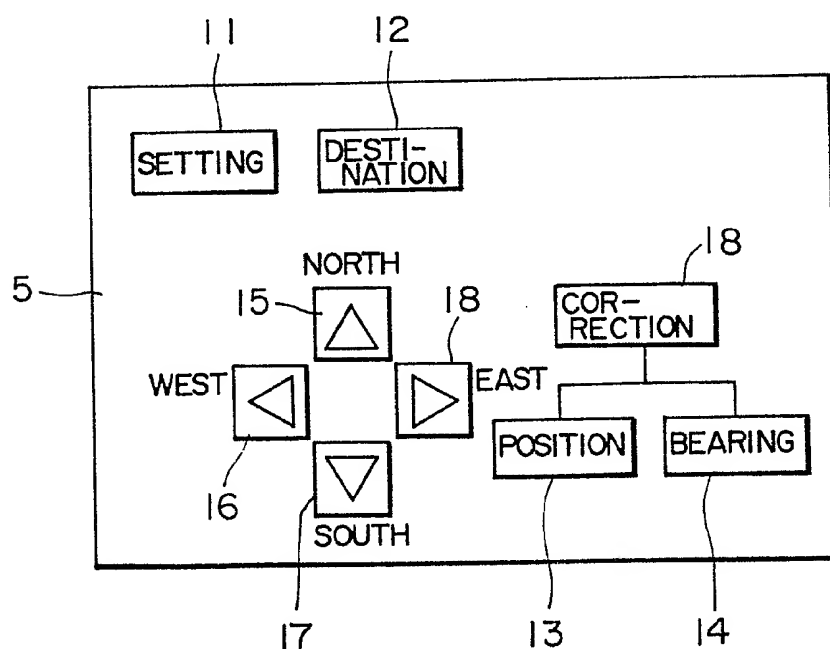50 m distant from said crossing.

FIG. 1
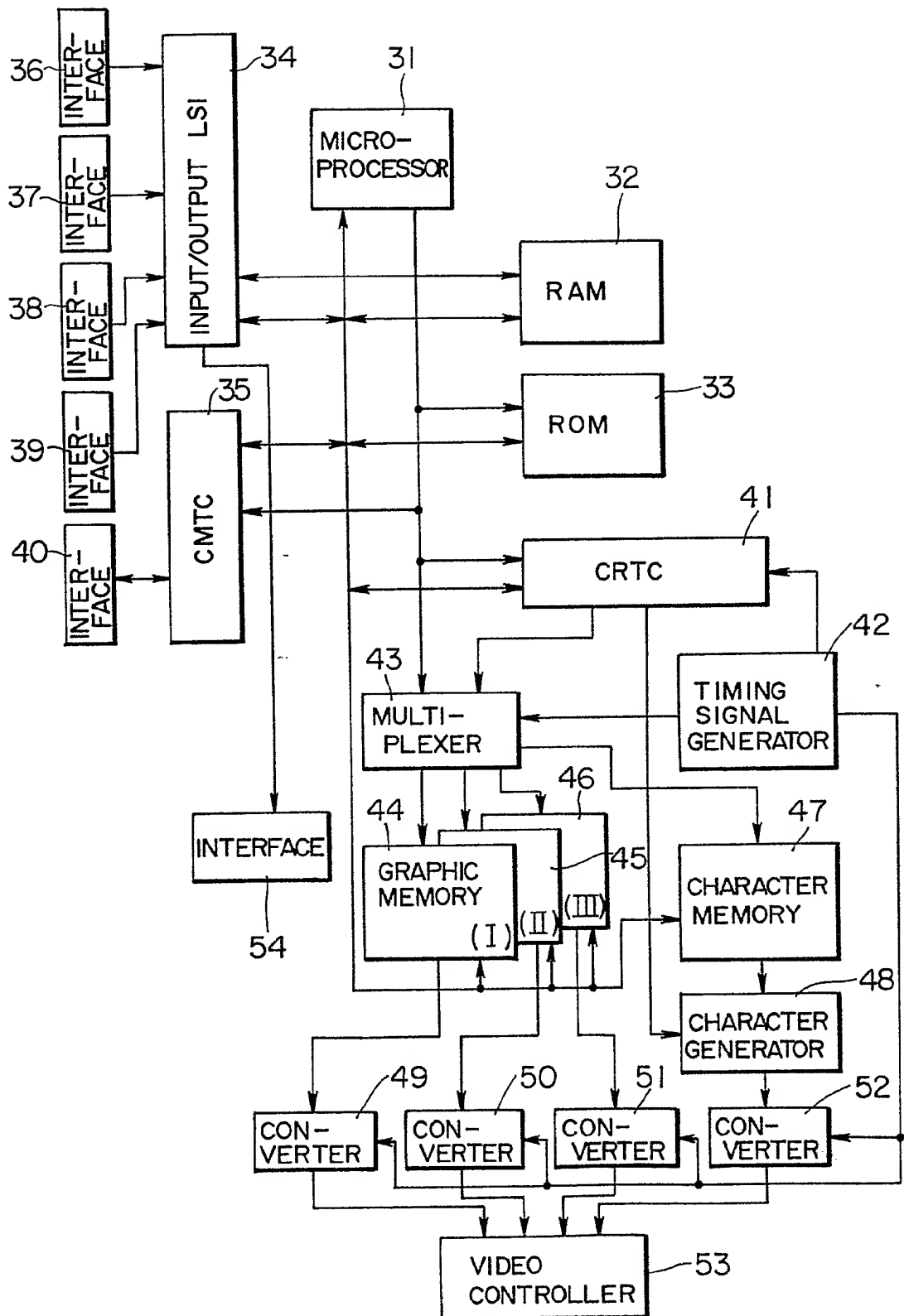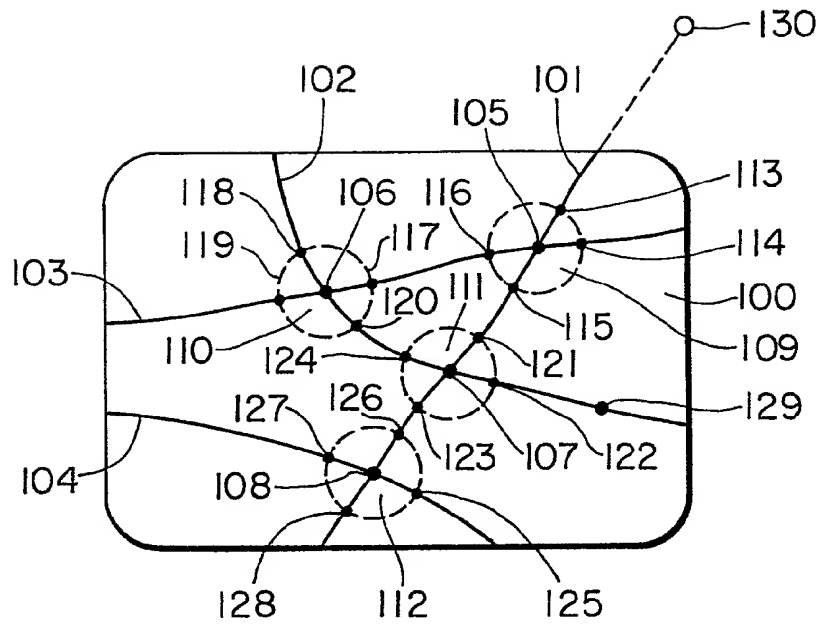
BEARING SENSOR — 2

BEARING SENSOR — 3

CAR SPEED PULSE SENSOR — 4

OPERATON SWITCH UNIT — 5

MICROCOMPUTER UNIT — 1

EXTERNAL STORAGE — 6

COLOR CRT — 7

AMPLI-FIER — 8

LOUD SPEAKER — 9

FIG. 2

SETTING — 11

DESTI-NATION — 12

NORTH

15 — △

WEST — ◁ — 16

EAST — ▷ — 18

SOUTH

17 — ▽

COR-RECTION — 18

POSITION — 13

BEARING — 14

5

FIG. 3

FIG. 4

FIG. 5

FIG. 6